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1. Your reference	P.74390 - JGL/JLM	05 MAR 1998
2. Patent application number *(The Patent Office will fill in this part)*		9804730.1
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	Formula One Administration Limited 14/16 Great Portland Street London W1N 6BL	
Patents ADP number *(if you know it)*		
If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom 739235000).	
4. Title of the invention	DATA COMMUNICATION SYSTEM	
5. Name of your agent *(if you have one)*	J A KEMP & CO	
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	14 SOUTH SQUARE GRAY'S INN LONDON WC1R 5LX	
Patents ADP number *(if you know it)*	26001	
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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing *(day / month / year)*
8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer "Yes" if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body: See note (d))*	Yes	

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Continuation sheets of this form	
Description	8
Claim*(s)*	2
Abstract	1
Drawing*(s)*	3 x 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	0
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application

Signature J.A. Kemp & Co. Date 5 March 1998
J.A. KEMP & CO.

12. Name and daytime telephone number of person to contact in the United Kingdom

Mr. J.L. Midgley
0171 405 3292

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DATA COMMUNICATION SYSTEM

This invention relates to a system for transmitting data, particularly audio and video signal data, to and from a moving object.

In order to provide real time communication of audio, video and data signals between a moving vehicle and a fixed ground station, the vehicle may be provided with an antenna for beaming a signal to a helicopter located above the car. The helicopter then relays the signal from the car to and from a fixed ground station. This system of communicating data between a moving vehicle and a fixed ground station has been particularly useful in the field of motor racing to provide video, audio and data signals from the cars and to allow data and audio signals to be transmitted back to the car.

Current on-board cameras use a microwave transmitter system for communication up to the helicopter. The helicopter then re-transmits a signal on a second microwave frequency to the fixed location.

There are a number of drawbacks associated with such a system. If a car that is providing the signal does not have a direct line of sight to the helicopter, for example because of tall trees or buildings at the side of the track, then the received signal may be weak or obscured completely. In such a situation, it is necessary for the helicopter to remain almost directly above the vehicle to maintain a consistent contact with the car. This can be difficult, particularly with high-speed racing such as Formula One where the helicopter is unable to match the speed of the cars it is attempting to follow. Alternatively, the helicopter can fly at a greater height to avoid objects coming between it and the car. However, this again can reduce the signal quality received by the helicopter due to the increased distance. This can also lead to problems with air traffic control. A further problem of using a helicopter to relay signals is its dependence upon the

weather. If the weather becomes unsuitable for flight then it is not possible to provide the signal relaying function at all.

A further limitation of the use of helicopters for relaying signals is the limited amount of weight that can be carried to allow the helicopter to remain at its station for the duration of a race. Similarly, there is a limitation on the amount of power that can be provided for running the radio frequency systems.

Therefore, according to the present invention there is provided a communication system including:

a video signal source and transmitter for transmitting said video signal provided on a mobile object;

a plurality of receivers for receiving said transmitted video signal and

control means for selectively receiving the transmitted video signal received by one of said receivers and outputting said selected signal.

According to the present invention there is also provided a method of communicating a video signal between a mobile object and a stationary location comprising transmitting the video signal from a transmitter on the mobile object;

receiving at said stationary location signals from a plurality of receivers; and

selecting one of the signals received by said receivers.

The present invention is preferably also arranged so that switching between receivers is carried on the basis of the position of the mobile object. The receivers are preferably arranged so that the area in which they can receive signals at an acceptable level overlaps with the corresponding area of the adjacent receiver.

The transmitters on the cars may be arranged to be able to transmit on a number of different frequencies.

Similarly, the receivers may also be adapted to receive on a number of different frequencies and on more than one frequency at a time.

The video signal is preferably transmitted from the mobile object to the receivers using a microwave carrier. This is preferably at 2.5 GHz although frequencies between 400 MHz and 40 GHz may also be used.

The present invention requires only a single frequency to transmit the video signal as there is no re-transmission of the signal as in the case of a helicopter-based system. This allows a doubling in the number of signals that can be transmitted for a given number of frequencies. Furthermore, because the transmission from each transmitter is received by a receiver at relatively close range, the transmission power can be reduced. This also allows the same frequency to be used simultaneously between another transmitter and receiver at a different location. This is not possible with helicopter based systems in which all signals have to go via the helicopter and so only one transmitter could use a given frequency in order to avoid interference.

By providing sufficient receivers to ensure that the signal transmitted is always received by at least one receiver there is never a break in transmission. As the signal is being transmitted substantially horizontally along the ground to a trackside receiver, trees and buildings do not present an obstruction to the signal path.

A specific embodiment of the present invention will now be described by way of example with reference to the accompanying drawings in which: -

Figure 1 shows an example of a layout of receivers around a section of racetrack;

Figure 2 shows a representative arrangement of receivers relative to each other and the respective switching positions for switching from one receiver to the next; and

Figure 3 shows a schematic layout of the arrangement

of one of the receivers according to the present invention.

Figure 1 shows an example of a section of racetrack and a suitable arrangement of receivers around such a track to provide continuous reception of a video signal from an on-board camera in a racing car. The embodiment of the present invention described herein relates to a system for providing communication of a video signal from a moving racing car to a fixed location such as an outside broadcast unit. Figure 1 shows a section of racetrack 1 with a number of receivers 2 arranged at appropriate locations around the track. Each receiver includes a directional helix antenna. The dashed lines in Figure 1 provide an indication of the detection angle of the antenna of each receiver.

The outputs from all the receivers are fed back to a controller at a central location where the signal from one of the receivers is selected as the most appropriate. The selected signal is then used to provide the output signal from the system, e.g. for broadcast.

It will be apparent that, by providing sufficient receivers around the periphery of the track, as the car travels around the track the video signal transmitted by the car is always receivable by at least one of the receivers.

In order to ensure this continuity of reception, there is some overlap in the detection range of one receiver and its neighbour. This overlap (preferably at least 20m) ensures that as the car travels from the reception area of one receiver to the reception area of the next receiver, the car passes through an area where the video signal transmitted by the car is received by the antennas of both receivers. At some point in this area, the system switches from using the signal from the first receiver to using the signal from the next receiver.

Figure 2 shows a schematic view of a section of a track showing the antennas (A_2, A_3, A_4, etc.) of a number of receivers. As the car enters from the right, it first

passes position P_1. The antenna A_2 is initially receiving the signal transmitted by the car. As the car continues to the point P_2, the car enters the reception range of the next antenna A_3 at which point the signal being output is received by A_3 as well as by A_2. However, the signal being received by A_2 is still the one being utilised to provide the output signal. As the car passes position P_3, the system switches from using the signal from A_2 to using the signal from A_3 although the signal from the car is still being received by A_2. As the car continues on through position P_4, antenna A_2 eventually becomes unable to receive the signal from the car so that only antenna A_3 is receiving the signal. This switching procedure is repeated as the car progresses around the track and moves from the reception area of one receiver to the next. As is clear from figure 2 switching takes place at a distance D_2, D_3 or D_4 before the car reaches the antenna of the receiver currently providing the video signal which is being utilised. This ensures that a good quality signal is still being received up until the changeover. If the changeover was delayed until the car was level with the antenna, the signal strength received by the antenna may drop off considerably as the car drops out of the optimum reception zone of the antenna.

The exact point at which switching takes place is very important. If switching occurs too early, e.g. at P_2, the strength of the signal received by A_3 may be weak. As described above, leaving switching until too late can result in the signal received by A_2 being too weak. If the received signal is weak then the output signal may be distorted or noisy. However, to determine the appropriate switching point it is not sufficient to simply measure the strength of the signal received by each receiver and then select the strongest of those. This can lead to a misleading indication of the best signal and hence the wrong switching position. One of the reasons for this is interference caused by the transmitted signal arriving at

the antenna indirectly, i.e. having reflected off some other object. This phenomenon, known as multipath, results in the direct and indirect signals having taken paths of different lengths to arrive at the receiver. Depending upon the difference in the path lengths, the two signals may constructively interfere, providing a stronger signal, or destructively interfere reducing the signal strength. Furthermore, as the car moves, this difference between the path lengths may change and so the signal strength may vary between being very weak and being very strong. This variation makes it difficult to use the signal strength as an accurate indicator of which receiver to use for the output signal.

The system of this invention determines the appropriate time to change from one receiver to the next based upon the position of the car relative to the antenna. This requires knowledge of the position of the receivers and the car. This can be determined in a number of ways. On a racetrack, data may be available from the time keeping system. This allows the position of the cars to be determined accurately at any time. However, there are a number of alternative ways of determining position. Apart from well-known systems such as GPS (Global Positioning System), it would be possible to use a custom system for providing position information, for example by utilising the receivers themselves to determine the distance from the car.

On a racetrack, which may be several kilometres long, the receivers may be a long way away from each other and from the controller at the central location. The simplest way of delivering the signals received by the receivers to the central controller is by directly connecting, e.g. via a cable, each receiver to the controller.

However, in an alternative embodiment of the present invention the receivers may be connected to a network (e.g. LAN). The network may link all the receivers or just a proportion of them in conjunction with other networks.

In a motor race, it is desirable to have cameras on more than one car. The system of the present invention can provide the facility for a number of cars to provide video signals. Each car transmits on a different frequency. Where two or more cars are in the reception area of the same receiver, the antenna receives both signals. The receivers contain filter circuitry for separating the two signals and relaying both the video signals back to the controller.

This system can be further developed to allow for addition cameras where the number of frequencies available for transmission is limited or if there are a large number of cars in a race. Furthermore it may be desired to have more than one signal being produced from each car (e.g. forward and rearward views). Under such circumstances a large number of channels may be required. If the bandwidth available is limited, it is possible to utilise the same frequency for signals provided by different cars. This is possible so long as cars transmitting on the same frequency are sufficiently far apart such that the receiver picking up the signal from one car does not pick up a significant amount of the signal from another car transmitting on the same frequency. This can be achieved by monitoring the position of the cars and where two cars using the same frequency are in danger of coming close enough to interfere with each other the controller will instruct the transmitter on the car to change to a different frequency which is not being used by any other car in close proximity or to stop transmitting. The position information used to determine switching between receivers may be used to determine the allocation of frequencies to the transmitters. In this way, several cars at different positions around the track can use the same frequency simultaneously. This represents a considerable advantage over the helicopter-based system that could only utilise a single transmitter per frequency. Furthermore with the present invention each transmitter only uses a single frequency rather than the two required with

the helicopter system, i.e. one for transmitting to the helicopter and one for the relay to the ground based receiver.

Each receiver comprises an antenna for receiving the transmitted microwave signal (see Figure 3). The receivers also include filters and de-modulators 4, for extracting the video signal from the received microwave transmission. The video signal is then sent to the central controller. The antennas are preferably helix antennas but these may be replaced by for beam antennas. The antennas may have an angular range of between 30° and 120° depending on their location.

Whilst this invention has been described in relation to a racetrack location, it is clearly applicable to other applications. The system is equally applicable to a non-closed track e.g. for a road race. Furthermore, the system could be used in any situation where the transmission of video (or other high bandwidth signals) from a moving object to a stationary object is required. Applications could include transmitting pictures from cars (e.g. police cars) to roadside receivers for transmission to other police cars or a central control room. The system could even be extended to provide a mobile video communication system.

Whilst the above described embodiment refers primarily to the communication of video data, it is intended that the system may also provide communication of audio and data signals both to and from the car.

CLAIMS

1. A communication system including:

a video signal source and transmitter for transmitting said video signal provided on a mobile object;

a plurality of receivers for receiving said transmitted video signal and

control means for selectively receiving the transmitted video signal received by one of said receivers and outputting said selected signal.

2. A system according to claim 1 wherein the receiver selected by the control means is based upon the position of the mobile object.

3. A system according to claim 1 or 2 wherein the receivers have a maximum range in which the signal from the transmitter can be received at an acceptable level wherein each receiver is arranged such that the range of the receiver overlaps with the range of the adjacent receiver or receivers.

4. A system according to any one of the preceding claims, wherein the control means changes from receiving the signal received by a first one of said transmitters to a second one of said transmitters at a pre-determined distance from the first receiver.

5. A system according to any one of the preceding claims wherein the receivers have helix antennas.

6. A system according to claim 5 wherein the antennas are arranged at a height of between 1.5 and 3 metres.

7. A system according to any one of claims 1 to 5 wherein the transmitter can be controlled to transmit on one of a plurality of frequencies.

8. A system according to claim 7 wherein the

transmission frequency of the transmitter is controlled by the control means.

9. A system according to any one of the preceding claims comprising one or more further mobile objects each provided with a transmitter, each transmitter simultaneously transmitting video signals to one or more of said receivers.

10. A system according to any one of the preceding claims wherein the receivers and the control means are all connected to a network.

11. A method of communicating a video signal between a mobile object and a stationary location comprising

transmitting the video signal from a transmitter on the mobile object;

receiving at said stationary location signals from a plurality of receivers; and

selecting one of the signals received by said receivers.

12. A method according to claim 11 wherein the selecting means changes to receiving a signal from a different receiver in accordance with the position of the mobile object.

13. A communication system substantially as described herein with reference to Figures 1 to 3 of the accompanying drawings.

14. A method of communicating a video signal substantially as described herein with reference to Figures 1 and 3 of the accompanying drawings.

ABSTRACT

The present invention provides a ground based video pick-up system for transmitting video signals produced on a moving object to one of a number of receivers at a fixed position and selecting the desired signal from the most appropriate one of those receivers.

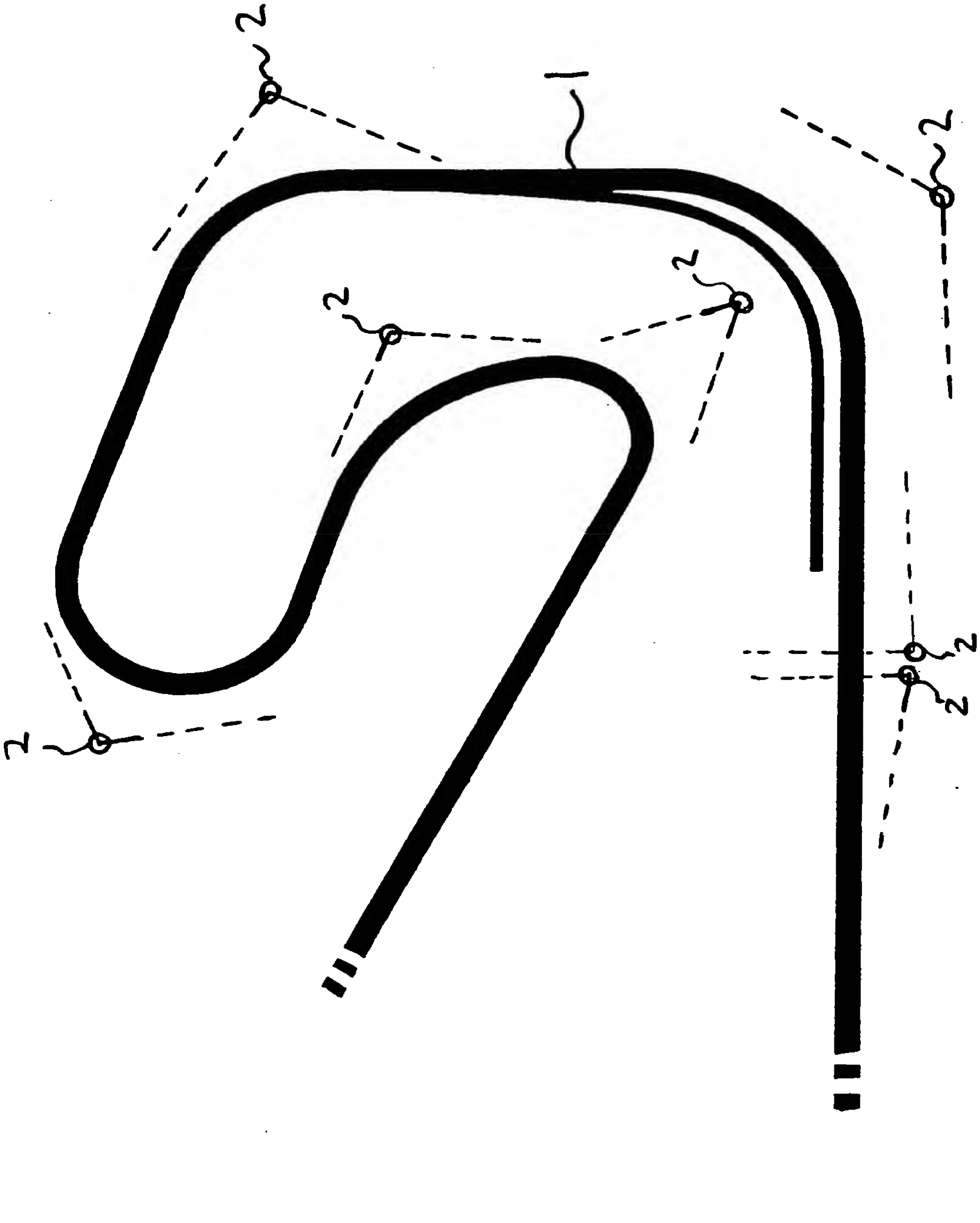
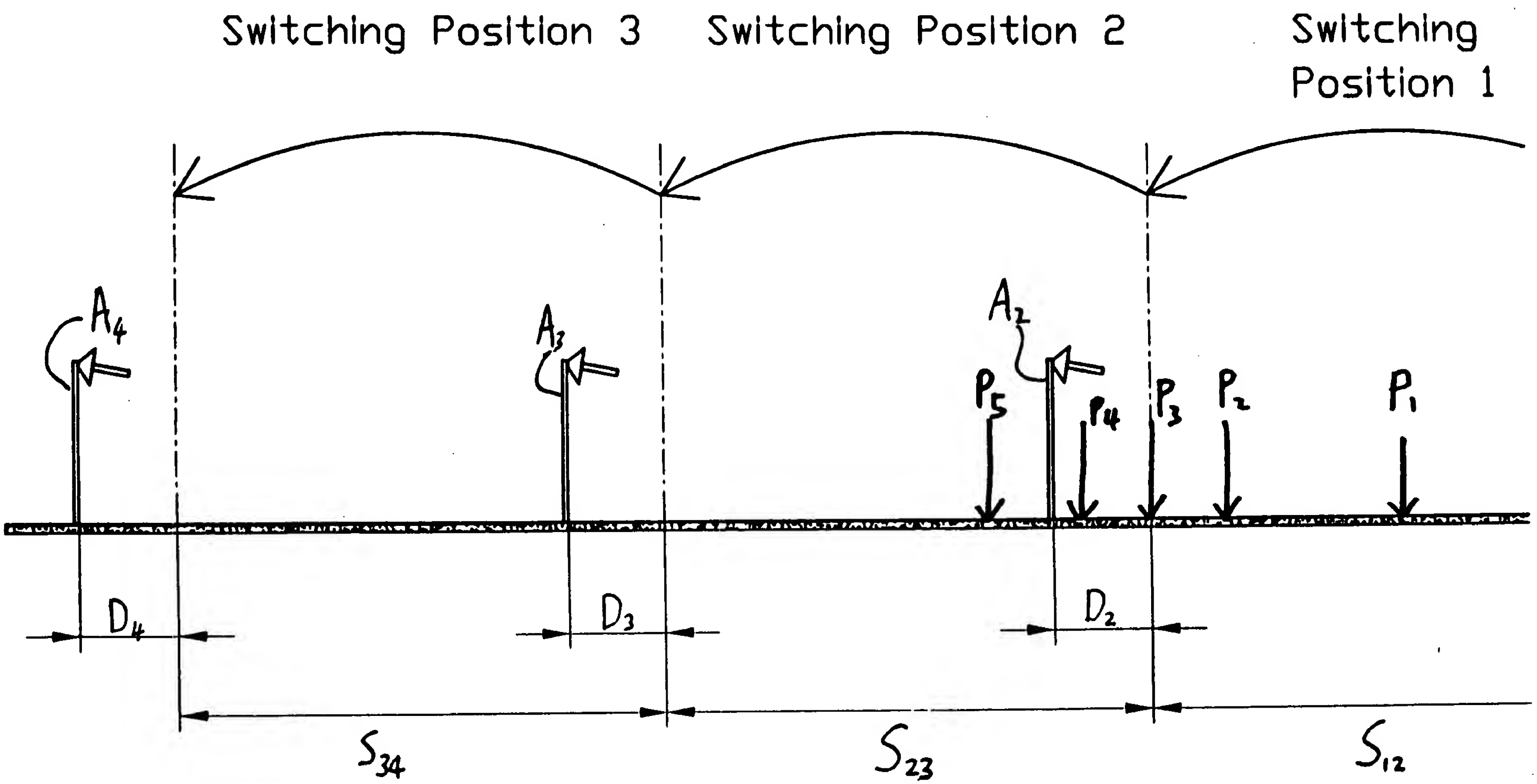


FIG.1



Switching Position 3
Switching Position 2
Switching Position 1
A4
A3
A2
P5
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P3
P2
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D4
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S34
S23
S12

FIG. 2

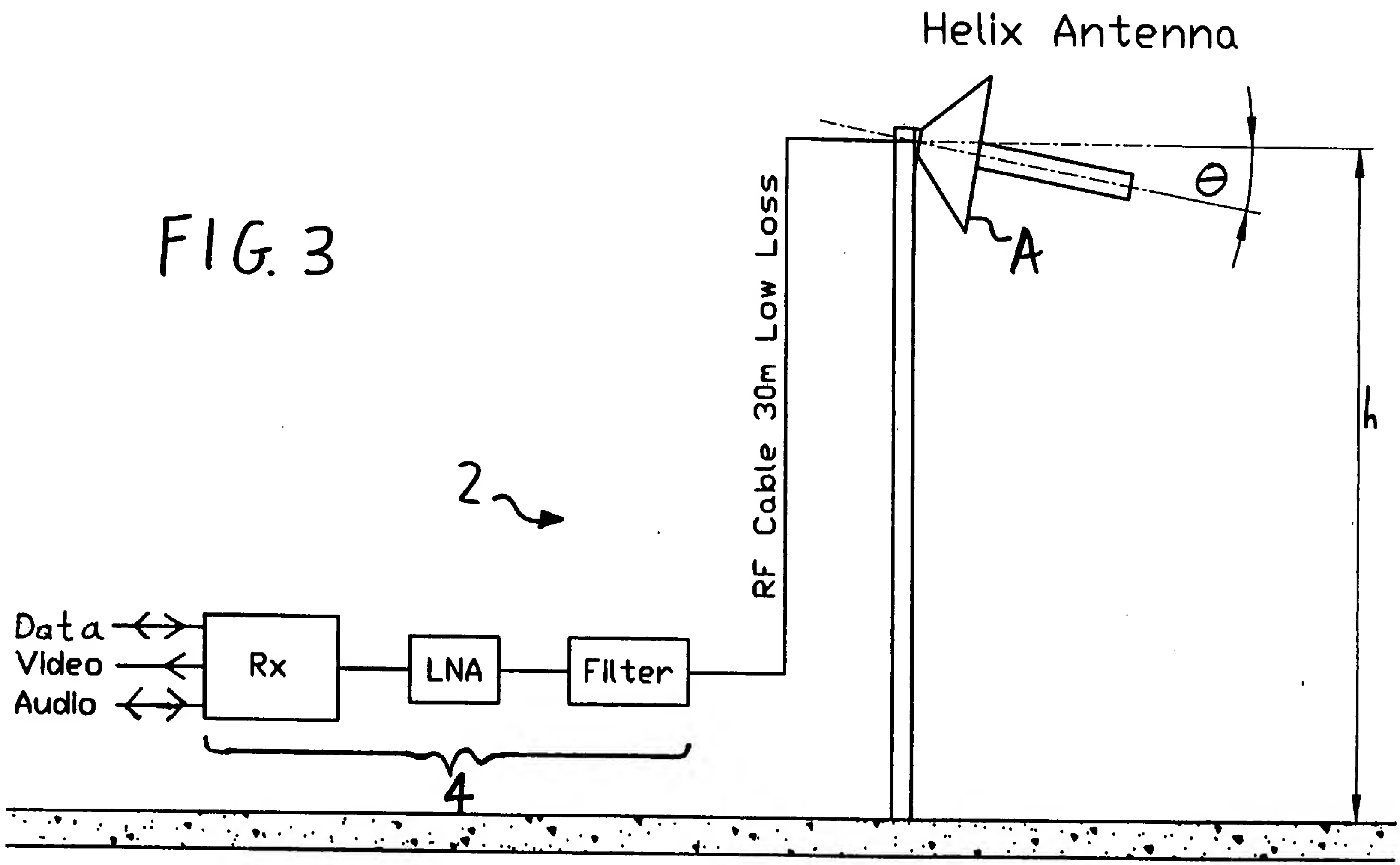
Helix Antenna
θ
A
h
RF Cable 30m Low Loss
2
Data
Video
Audio
Rx
LNA
Filter
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FIG. 3

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